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14. ABSTRACT

Our research using positron emission tomography (PET) has revealed the brain regions that are selectively activated by specific tasks developed to assess various visual-spatial abilities. We have also been obtaining convergent evidence showing that when activity in those areas is inhibited by Transcranial Magnetic Stimulation (TMS), so is performance on the relevant tasks. Furthermore, previous studies have shown that TMS (applied at a different frequency) can also be used to *facilitate* processing; indeed, it may be possible to boost an individual's "visual intelligence" following this procedure. A frameless stereotactic device (Radionics' Optical Tracking System) was purchased with these funds to allow us to use the subjects' brain scans to localize the sites of cortical activation more precisely and thereby be able to direct TMS to very specific loci in a given person's brain. However, Radionics has failed to comply with their agreement to provide the service and software necessary to "read" the brain imaging data; therefore the equipment has been unusable. The Harvard Office of the General Counsel successfully negotiated a refund, which was received in early February 2001. The funds will be used to purchase a similar, but less expensive and more effective device; in addition, the remainder of the funds will be used to purchase a Diffuse Optical Tomography system (a brainscanning device which can be used simultaneously with TMS). This reallocation of funds was approved by our Program Officer.

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As noted originally in our DURIP proposal, our AFOSR grant (#F49620-98-1-0334) was focused in part on identifying brain regions that play key roles in visual cognition of the sort used by pilots, navigators, and observers. Our primary method has been positron emission tomography (PET), which has revealed the brain regions that are selectively activated by specific tasks designed to tap various visual and spatial abilities. We have also been obtaining convergent evidence from Transcranial Magnetic Stimulation (TMS) by showing that when activity in those areas is inhibited, so is performance on the relevant tasks. Moreover, TMS can be used not only to inhibit processing, but also to facilitate it. In some studies (see Pascual-Leone et al., 1998), such facilitation has been shown to last hours after stimulation. This procedure has exciting potential practical implications; indeed, it may be possible to boost an individual's "visual intelligence" following this procedure.

For these reasons we desired to purchase a frameless stereotactic device that would allow us to use subjects' brain scans to localize cortical activation precisely—and thereby be able to direct TMS to the appropriate loci in a given person's brain. Our original plan was to purchase this equipment from a company called Elekta (based in Sweden). However, we then discovered that a local company, Radionics Inc., offered a better product and also promised us superior software support, which was a major motivation for turning to them. Thus, we ordered their "Optical Tracking System" for our research.

Since receiving the machine almost a year and a half ago, we have been plagued by problems. These problems arise specifically out of Radionics' failure to comply with their agreement to provide service and software. After repeated attempts to have them fix the necessary software (without which we could not use the device to read the brain imaging data), we requested our money back; in the meantime, another product has become available, which is clearly satisfactory (and is used by colleagues in other places). After Radionics failed to respond adequately to our requests for service we engaged the Office of the General Counsel (OGC) at Harvard University. In January, 2001, the OGC was finally able to negotiate a full refund, and the money was returned to the University in early February.

We have remained in close contact with our Program Officers, Willard Larkin and John Tangney, throughout, and plan to reallocate the funds in the following way:

1. We plan to purchase another frameless stereotactic device, developed by BrainSight. The new BrainSight system can perform all the functions that are needed for the coregistration of external devices (e.g. a TMS coil or a DOT sensor array) with the previously acquired brain MRIs of study participants. The developers of BrainSight are committed to providing users in the cognitive neuroscience community with a flexible tool and with the necessary support. Indeed, we have agreed to be a beta site for the BrainSight system, at a considerable savings in cost.

2. Given the savings in cost, we plan to allocate some of the funds to have a Diffuse Optical Tomography system built. This is another brain scanning method, relying on near infrared light, rather than magnetic fields (fMRI) or radioactive tracers (PET). It can be used within my laboratory (rather than in a specially devoted hospital unit), and can be used simultaneously with TMS. Should we be funded for continuing work for the AFOSR, this system will be integral to our research program.

Reference

Pascual-Leone A, Tormos JM, Keenan J, Catala MD. 1998. Study and modulation of cortical excitability with transcranial magnetic stimulation. *Journal of Clin Neurophysiology 15*: 333-343.